LAWRENCE
LIVERMORE
NATIONAL
LABORATORY

UCRL-JRNL-206410

High Fill-Factor Transport Experiments on the HCX

L. R. Prost, P. A. Seidl, S. M. Lund

September 7, 2004

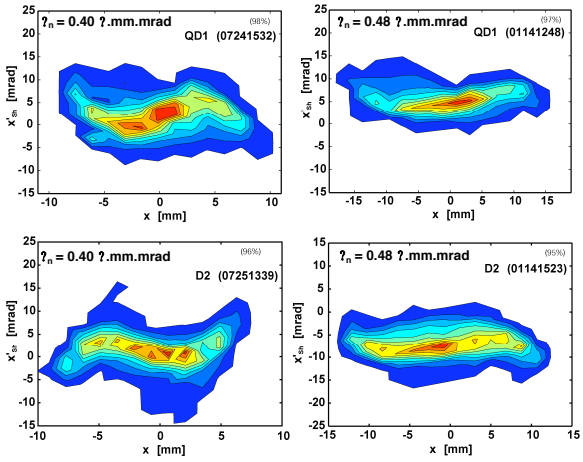
HIF News (JUL/AUG 2004) LBNL-PUB-844-07-08/04

High Fill-Factor Transport Experiments on the HCX

Heavy-ion induction linacs have application as drivers for high energy density physics studies and ultimately as drivers for inertial fusion energy. Experiments on the High-Current Experiment (HCX) at LBNL explore heavy-ion beam transport at high fill factors (*i.e.*, the ratio of the maximum transverse extent of the beam to the physical aperture). The fill factor has a large impact on the cost of multi-beam induction accelerators, the 80% fill factor compared with 60% would reduce the cost of an HIF driver by about 1/3.

With a coasting low-emittance 1 MeV K^+ beam, transport through ten electrostatic quadrupoles was achieved at high beam fill factor (80%) without observed emittance growth and with little beam loss (≤1%), even though the initial beam distribution is neither ideal nor in thermal equilibrium, see Figure. While 10 quadrupoles are too few for settling questions of emittance evolution in a long system, they are very relevant for studying the rapid initial evolution of the emittance and beam profile that is expected in the front end of an accelerator. Studies at higher fill factors are planned, so that the failure mode can be established.

Good envelope control was achieved, suggesting that, in a longer lattice of similar design, re-matching only every ten lattice periods (at 80% fill factor) will be sufficient. Agreement was reached between an improved envelope model and the data. Improvements to the model are: realistic quadrupole fringe fields based on 3D field calculations; quadrupole E_z from the 3D lattice structure and corresponding radial focusing force; and corrections due to the grounded slit plates of the intercepting diagnostics that short out the self-field of the beam near those plates. We also find that understanding and controlling the time dependence of the envelope parameters is critical to achieving high fill factors, notably because of the injector and matching section dynamics. — *L. R. Prost, P. A. Seidl, and S. M. Lund*



(a) (b)

Figure: Horizontal phase-space diagrams measured before (top) and after (bottom) the electrostatic transport section for (a) 60% fill factor; (b) 80% fill factor, for a single time slice at mid-pulse.

This work was performed under the auspices of the U.S. Department of Energy by the University of California, Lawrence Livermore National Laboratory under Contract W-7405-Eng-48.